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The Lachnosterna of the Vicinity of Manhattan, Kan.¹

JAMES W. MCCOLLOCH and WM. P. HAYES.

The genus *Lachnosterna* Hope offers an excellent field for a study of almost any phase of investigation of insect bionomics. Composed of approximately 235 species distributed over the Western hemisphere, one need not lack for material. The economic entomologist has been interested in this group for many years, and to-day a vast amount of work is being done with regard to economic studies. As pointed out by Glasgow (1916), the distribution of the species is an important subject, since it offers a basis for the study of problems relating to the origin and source, the diversification and the dispersal of animal forms in North America.

SOURCE OF DATA.

The following local list of *Lachnosterna* is based primarily on 41,633 specimens collected by the writers during the years 1916, 1917 and 1918. The work has been done in connection with an investigation on the biology of *Lachnosterna* of Kansas, which is one phase of studies on insects injurious to the roots of staple crops being made at this station. In addition, use has been made of the collection of the department of entomology, which contains approximately 2,000 pinned specimens, and reference has been made to the literature on distribution relative to the area under discussion.

ACKNOWLEDGMENTS.

The writers are under many obligations to Mr. J. J. Davis, of the Federal Bureau of Entomology, for the identification of many specimens and for his kindness in supplying the College collection with a large series of beetles. The determination of the rarer species have been made by Mr. Davis, or verified by him. Mr. Warren Knaus has at all times been ready to supply the writers with information concerning the various species, and has kindly identified some of the material.

IMPORTANCE OF THE GENUS.

The various species of *Lachnosterna* have long been recognized as among the most serious pests of crops. The larvæ, or white grubs, are subterranean in their habits, feeding on the roots of cultivated crops and grasses. Corn and timothy seem to suffer the greatest injury, but within recent years considerable injury has been noted in the fields of small grains. Nursery plantings and strawberry beds are often devastated, and in the Northern states the grubs have been particularly bad in beds of conifer seedlings.

The adults feed almost entirely on the foliage of trees, small fruits and shrubs, the amount of injury varying with the seasons and with the number of beetles present. Davis (1916, p. 270) reports the almost total defoliation of the timber over large sections of Illinois, Iowa, Wisconsin and Michigan in

1. Contribution No. 45, from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 100 of the Experiment Station.

[NOTE.—Glasgow (1916) placed the generic name *Lachnosterna* in synonymy and re-established the name *Phyllophaga*, proposed by Harris. At the time this paper was written (1913) there was some controversy as to whether this change would be adopted (see Review Applied Ento., 5:63), and it was felt that *Lachnosterna* should stand, since it was so well known even among the laity. Later studies, however, indicate that *Lachnosterna* should revert to synonymy and *Phyllophaga* be retained.—Feb. 10, 1922.]

1914. To illustrate the number of beetles present during that year, he states that "at one small town in Wisconsin the beetles accumulating beneath the ten arc lights of the town were hauled away each morning, for a period of ten days or two weeks, by the wagonload."

FACTORS CONTROLLING DISTRIBUTION.

The distribution of animals is usually considered from a static or from a dynamic standpoint. Often both are considered, and there is frequently an overlapping of the two. The static viewpoint attempts to correlate the distribution with various arbitrarily chosen standards, as temperature, natural barriers, etc., which are subdivided into areas or zones. The dynamic viewpoint explains distribution in terms of the relation of the animals to their complete environmental complex. Within recent years this method has superseded the former. The study of animal distribution may be taken up from many sides and in many ways, and probably the most fundamental of these considers the dependence of the animal on its environment.

Forbes was one of the first to recognize the importance of a thorough study of the May beetles in relation to their environmental complex, and he has done much along this line. He states (1907, p. 447) that "for a practical knowledge of these destructive insects it is necessary that we should know the various species of them which do serious injury to agricultural and to horticultural crops; the life histories of all these species; their relative numbers in different parts of the state in different years and in different periods of years their food, both as grubs and as adult beetles, including their common preferences where several kinds of food are available to them; their significant habits, especially those of reproduction; their relations to variety of weather and to seasonal change; their modes, times and places of hibernation; the range of their daily movements and of their movements of migration and dispersal; their enemies, their diseases, especially those of a contagious character, and other natural checks on their multiplication; their relation to varieties of soil, to its physical condition, its moisture and its exposure to the sun; their relation to varieties of the subsoil also; the effects on their continuance and increase of various agricultural operations and kinds of farm management; and their own effects, under varying conditions, on the several kinds of crops subject to injury by them."

Davis (1916) began a study of the May beetles in 1911 with the idea of working out the life history of every species available. He is also working out the distribution of the species in all parts of the country in relation to soil, timber, farming methods and other environmental conditions.

There are a number of factors entering into the environmental complex, of which latitude, altitude, temperature, moisture, food and soil are probably the most important. These factors do not act separately, but there is an overlapping, *e. g.*, latitude and altitude are closely correlated with temperature, and possibly moisture, and these are operative on the food plants as well as on the insects. Davis (1916, p. 268) says that there are at least three factors limiting the distribution of the different species of *Lachnosterna*, namely, soil, trees, and elevation.

METHODS OF DISTRIBUTION.

Distribution of migration occurs principally in the adult stage, since the grubs are subterranean in their habits, are very sluggish, and are not capable

of rapid locomotion. They change their location only when forced to by the exhaustion of the food supply. The beetles, on the other hand, feed principally on the foliage of trees. They are nocturnal in their habits, flying back to the fields at the approach of dawn. From the data at hand it is apparent that migration occurs during the adult stage, and may be by flight, winds, storms and floods.

GENERAL DISTRIBUTION.

The genus *Lachnosterna*, composed of approximately 232 species (Dalla Torre, 1912), is confined almost entirely to the Western Hemisphere, extending from the Hudson bay territory to Argentina. The largest number of species are known from the United States, due probably to the fact that more systematic collecting has been done in this country. According to Glasgow (1916) this genus is represented in the United States by 97 species. In some cases the distribution is fairly well established, and while many collections have been made in various localities, it is still necessary for more extensive work to be done. Davis (1916), Forbes (1916), and Sanders and Fracker (1916) have shown that there may be a great variation in the number and abundance of the species present within a rather limited area. In order that the complete distribution of each species may be worked out for the United States collections should be made in many localities in each state. These collections should cover a period of years and should be made at lights, on food plants and from the soil.

In so far as the writers have been able to determine, no systematic collections of *Lachnosterna* have been made in Kansas. The museums of the Agricultural College and the University of Kansas contain many specimens, but in most cases the accompanying data are too meager to determine the relative abundance and habits of the species. Several papers have been published in the Transactions of this Academy, notably Popenoe (1877) and Knaus (1898), which contain lists of the *Lachnosterna* of the state. In addition, Knaus (1897) published on the *Lachnosterna* of Kansas, in which he listed 47 species and varieties, together with a few notes on the distribution, abundance and period of activity.

DISCUSSION OF THE *LACHNOSTERNA* OF RILEY COUNTY, KANSAS.

In the present paper the writers have attempted to bring together all the available records relative to the presence of *Lachnosterna* in Riley county. An annotated list of species is presented, together with certain notes on relative abundance, period of flight, and food. As the work progresses it is planned to enlarge this phase of the work to include the entire state. The present list represents twenty-three species, obtained in a collection of 41,633 specimens made by the writers and six species represented in the collection of the Agricultural College, or reported in the literature.

ANNOTATED LIST OF *LACHNOSTERNA* OF RILEY COUNTY.

SPECIES IN THE COLLECTION OF THE WRITERS.

Lachnosterna lanceolata Say.

1824. *Melolontha lanceolata* Say, Journ. Acad. Nat. Sci. Phila. III, p. 242; LeConte, Ed. 1869, II, p. 142.

1850. *Tostegoptera lanceolata* Blanchard, Cat. of Coll. Ent. I, p. 149.

1855. *Tostegoptera lanceolata* Burmeister, Handb. Ent. IV, p. 356.

1856. *Ancylonycha lanceolata* Lacordaire, Gen. Coll. III, p. 285.
 1856. *Lachnosterna lanceolata* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 237.
 1887. *Lachnosterna lanceolata* Horn, Trans. Amer. Ent. Soc. XIV, p. 216.
 1889. *Lachnosterna lanceolata* Smith, Proc. U. S. Nat. Mus. XI, p. 493.
 1916. *Phyllophaga lanceolata* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

One of the most common species, being especially abundant on the high prairies. During the past three years 11,300 beetles, or 27 per cent of the total collections, have been made of this species.

Lanceolata differs from most of the members of this genus in that the adults are active during the day, the females are wingless, and pupation occurs early in the spring.

Collections: On food plants and flying, 11,299; in soil, 1; total, 11,300.

Period of flight: June 11 to July 30.

Principal food plants:² Ironweed, evening primrose, clover.

Incidental food plants: Pepper grass, shoestring plant, bladder ketmia, vervain, false boneset, hoary aster, milfoil, little ragweed, thistle, little blue stem, *Liatris*, big blue stem, Sampson's snakeroot, goldenrod, crab grass, sunflower, pigweed, sumach, bindweed, venus' looking-glass, corn, oats, cocklebur.

Additional notes: The collection of the Agricultural College contains a large series of beetles taken on weeds and trees in June, 1902.

Lachnosterna prætermissa Horn.

1887. *Lachnosterna prætermissa* Horn, Trans. Amer. Ent. Soc. XIV, p. 223.
 1889. *Lachnosterna prætermissa* Smith, Proc. U. S. Nat. Mus. XI, p. 495.
 1889. *Lachnosterna definita* Smith, Proc. U. S. Nat. Mus. XI, p. 501.
 1916. *Phyllophaga prætermissa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.
 1916. *Phyllophaga definita* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

This species is rare in Riley county and hitherto has not been recorded from the state. A few specimens were taken in 1917 and 1918.

Collections: At lights, 7; total, 7.

Period of flight: May 16 to June 11.

Lachnosterna longitarsa Say.

1824. *Melolontha longitarsa* Say, Journ. Acad. Sci. Phila. III, p. 241.
 1856. *Lachnosterna longitarsa* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 240.
 1887. *Lachnosterna longitarsa* Horn, Trans. Amer. Ent. Soc. XIV, p. 226.
 1889. *Lachnosterna longitarsa* Smith, Proc. U. S. Nat. Mus. XI, p. 496.
 1916. *Phyllophaga longitarsa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

A rare species in this locality, appearing late in the season, about 73 per cent of the collection has been females.

Collections: At lights, 78; on food plants, 1; in soil, 1; total, 80.

Period of flight: June 25 to August 2.

Food plants: One male was taken on elm in 1917.

Lachnosterna futilis LeConte.

1850. *Lachnosterna futilis* LeConte, Lake Superior, Its Phys. Char. Veg. and Animals (Agassiz), p. 226.
 1855. *Ancylonycha gibbosa* Burmeister, Handb. Ent. IV, 2, p. 324.
 1856. *Lachnosterna futilis* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 243.
 1856. *Lachnosterna decidua* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 246.
 1856. *Lachnosterna sericornis* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 247.
 1873. *Lachnosterna futilis* LeConte, Proc. Acad. Nat. Sci. Phila. XXV, p. 330.
 1887. *Lachnosterna gibbosa* Horn, Trans. Amer. Ent. Soc. XIV, p. 230.
 1889. *Lachnosterna gibbosa* Smith, Proc. U. S. Nat. Mus. XI, p. 497.
 1916. *Phyllophaga futilis* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
 1916. *Phyllophaga gibbosa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
 1916. *Phyllophaga decidua* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
 1916. *Phyllophaga sericornis* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

Futilis ranks fourth in the number of beetles taken in the past three years, comprising 11 per cent of the collections. Of these, 93 per cent were collected

2. The food plants in all cases are listed in the order of the apparent preference as shown by the number of beetles collected.

at lights. In the collection from food plants the proportion of sexes has been about equal, while in the collections at lights over 90 per cent have been males. *Futilis* has a rather wide range of food plants, having been taken on 23 different plants.

Collections: At lights, 4,455; on food plants, 330; in soil, 5; total, 4,790.

Period of flight: April 18 to July 21.

Principal food plants: Hackberry, hawthorne, horse chestnut, linden, elm, locust.

Incidental food plants: Birch, cherry, Norway maple, spirea, coffee tree, oak, box elder, ash, plum, rose, mulberry, silver poplar, sumac, catalpa, apple.

Additional notes: The Agricultural College collection contains one specimen found feeding on *Ceanothus ovatus*, May 23, 1889, and one specimen taken on willow, May 22, 1889.

Lachnosterna congrua LeConte.

1856. *Lachnosterna congrua* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 243.

1873. *Lachnosterna congrua* LeConte, Proc. Acad. Nat. Sci. Phila. XXV, p. 330.

1887. *Lachnosterna congrua* Horn, Trans. Amer. Ent. Soc. XIV, p. 232.

1889. *Lachnosterna congrua* Smith, Proc. U. S. Nat. Mus. XI, p. 498.

1916. *Phyllophaga congrua* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 372.

This species is rare, having been taken in small numbers in 1917 and 1918. The collections thus far made contain only males.

Collections: At lights, 28; on food plants, 1; total, 29.

Period of flight: May 16 to June 10.

Food plant: Hackberry.

Lachnosterna crassissima Blanchard.

1850. *Ancylonycha crassissima* Blanchard, Cat. Coll. Ent. Mus. Nat. Hist. de Paris I, p. 133.

1856. *Lachnosterna obesa* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 251.

1856. *Lachnosterna robusta* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 257.

1873. *Lachnosterna obesa* L. Conte, Proc. Acad. Nat. Sci. Phila. XXV, p. 330.

1875. *Lachnosterna robusta* Horn, Trans. Amer. Ent. Soc. V, p. 143.

1887. *Lachnosterna generosa* Horn, Trans. Amer. Ent. Soc. XIV, p. 222.

1887. *Lachnosterna crassissima* Horn, Trans. Amer. Ent. Soc. XIV, p. 239.

1889. *Lachnosterna generosa* Smith, Proc. U. S. Nat. Mus. XI, p. 495.

1889. *Lachnosterna crassissima* Smith, Proc. U. S. Nat. Mus. XI, p. 499.

1916. *Phyllophaga crassissima* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 372.

1916. *Phyllophaga obesa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 372.

1916. *Phyllophaga robusta* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 372.

1916. *Phyllophaga generosa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 372.

Crassissima is the predominating species in the area under consideration. During the past three years 14,510 specimens, or 35 per cent of the total collections, have been of this species. In the work thus far conducted over 99 per cent of the beetles have been taken at lights. While regular collections have been made on about forty species of plants, very few beetles have been found on the plants under observation. Schwarz (1891) says this species probably feeds on grass or low herbage. The males greatly predominate in the collections made at lights, comprising 78 per cent of the beetles taken.

Collections: At lights, 14,406; on food plants, 65; in soil, 39; total, 14,510.

Period of flight: April 23 to August 17.

Food plants: Strawberry, elm, oak, catalpa, apple, linden, locust, birch, hackberry, dock, hawthorne, box elder, horse chestnut, ash.

Lachnosterna inversa Horn.

1887. *Lachnosterna inversa* Horn, Trans. Amer. Ent. Soc. XIV, p. 241.

1889. *Lachnosterna inversa* Smith, Proc. U. S. Nat. Mus. XI, p. 500.

1916. *Phyllophaga inversa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

Exceptionally rare in this locality, being taken only in 1917.

Collections: At lights, 4; total, 4.

Period of flight: May 26 to June 17.

Lachnosterna bipartita Horn.

1887. *Lachnosterna bipartita* Horn, Trans. Amer. Ent. Soc. XIV, p. 242.
 1889. *Lachnosterna bipartita* Smith, Proc. U. S. Nat. Mus. XI, p. 500.
 1916. *Phyllophaga bipartita* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

Bipartita has been relatively common in the collections at lights during the past three years. It is of interest to note, however, that only six females were found. The collections from trees have contained few specimens of the species.

Collections: At lights, 570; on food plants, 8; in soil, 8; total, 586.

Period of flight: May 14 to July 8.

Food plants: Willow, apple, locust, birch, peach.

Lachnosterna vehemens Horn.

1887. *Lachnosterna vehemens* Horn, Trans. Amer. Ent. Soc. XIV, p. 244.
 1889. *Lachnosterna vehemens* Smith, Proc. U. S. Nat. Mus. XI, p. 501.
 1916. *Phyllophaga vehemens* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

Vehemens was fairly numerous in this locality in 1916 and 1917. It is one of the first species to appear in the spring. The collections thus far are very indefinite as to the food of these beetles.

Collections: At lights, 422; on food plants, 6; total, 428.

Period of flight: April 18 to June 23.

Food plants: Hawthorne, horse chestnut, hackberry.

Additional notes: The Agricultural College collection contains four specimens taken on plum May 9, 1892.

Lachnosterna fervida Fabricius.

1775. *Melolontha fervida* Fabricius, Species Insectorum, Tomus I, p. 36.
 1801. *Melolontha quercina* Knoch, Neue. Beyt. zur Insect, Theile I, p. 74.
 1855. *Ancylonycha fervida* Burmeister, Handb. Ent. IV, 2, p. 339.
 1888. *Lachnosterna arcuata* Smith, Insect Life I, p. 183.
 1889. *Lachnosterna arcuata* Smith, Proc. U. S. Nat. Mus. XI, p. 503.
 1916. *Phyllophaga fervida* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 370.
 1916. *Phyllophaga quercina* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 370.
 1916. *Phyllophaga arcuata* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 370.

This species is represented in the collections by seven males taken in 1917.

Collections: At lights, 7; total, 7.

Period of flight: May 30 to June 23.

Lachnosterna fusca Froelich.

1799. *Melolontha fusca* Froelich, Der Naturforscher, Stueck 26, p. 99; and Stueck 29 (1802), p. 113.
 1817. *Melolontha fervens* Gyllenhal, Schon. Syn. Ins. I, 3, p. 171; appendix, p. 74.
 1837. *Rhizotrogus fervens* Kirby, Fauna. Bor. Amer. IV, p. 132.
 1850. *Ancylonycha fusca* Blanchard, Cat. Coll. Ent. Mus. Nat. Hist. de Paris I, p. 133.
 1856. *Lachnosterna fusca* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 244.
 1861. *Lachnosterna fusca* Candèze, Mem. Soc. Sci. Liege XVI, p. 347.
 1884. *Lachnosterna fusca* Casey, Contrib. Col. N. Amer., p. 38.
 1887. *Lachnosterna fusca* Horn, Trans. Amer. Ent. Soc. XIV, p. 245.
 1889. *Lachnosterna fusca* Smith, Proc. U. S. Nat. Mus. XI, p. 505.
 1916. *Phyllophaga fusca* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
 1916. *Phyllophaga fervens* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

This species is not common to Riley county, and with the exception of 1917 has been exceptionally rare. Practically all of the specimens have been taken at lights.

Collections: At lights, 58; on food plants, 2; total, 60.

Period of flight: April 22 to June 17.

Food plants: Oak, linden.

Additional notes: The Agricultural College collection contains the following specimens: One at the roots of horse radish, April 15, 1889; two feeding on plum trees, April 28, 1889.

Lachnosterna corrossa LeConte.

1856. *Lachnosterna corrossa* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 249.
 1856. *Lachnosterna affinis* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 252.
 1887. *Lachnosterna affinis* Horn, Trans. Amer. Ent. Soc. XIV, p. 233.
 1887. *Lachnosterna corrossa* Horn, Trans. Amer. Ent. Soc. XIV, p. 255.
 1889. *Lachnosterna affinis* Smith, Proc. U. S. Nat. Mus. XI, p. 498.
 1889. *Lachnosterna corrossa* Smith, Proc. U. S. Nat. Mus. XI, p. 512.
 1916. *Phyllophaga corrossa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 372.
 1916. *Phyllophaga affinis* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 372.

A rare species in the area under discussion. All of the specimens were taken at lights, except one female found feeding on a weed in pasture land at 10 a.m., June 11, 1918.

Collections: At lights, 17; on food plants, 1; total, 18.

Period of flight: May 17 to June 23.

Lachnosterna rugosa Melsheimer.

1846. *Ancylonycha rugosa* Melsheimer, Proc. Acad. Nat. Sci. Phila. II, p. 140.
 1855. *Lachnosterna rugosa* Burmeister, Handb. Ent. IV, 2, p. 328.
 1856. *Lachnosterna rugosa* LeConte, Journ. Acad. Nat. Sci. Phila. (2), III, p. 252.
 1887. *Lachnosterna rugosa* Horn, Trans. Amer. Ent. Soc. XIV, p. 259.
 1889. *Lachnosterna rugosa* Smith, Proc. U. S. Nat. Mus. XI, p. 513.
 1916. *Phyllophaga rugosa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

Rugosa is one of the more common species, comprising about 5 per cent of the total collections. This species is a rather general feeder, as will be noted in the list of food plants.

Collections: At lights, 1,822; on food plants, 228; in soil, 11; total, 2,061.

Period of flight: April 23 to July 12.

Principal food plants: Willow, locust, hawthorne, hackberry, silver poplar and birch.

Incidental food plants: Box elder, oak, cottonwood, coffee tree, horse chestnut, cherry, plum, Norway maple, peach, persimmon, pear, elm, redbud, strawberry, ash, spirea, apple, linden and catalpa.

Lachnosterna implicita Horn.

1887. *Lachnosterna implicita* Horn, Trans. Amer. Ent. Soc. XIV, p. 282.
 1889. *Lachnosterna implicita* Smith, Proc. U. S. Nat. Mus. XI, p. 515.
 1897. *Lachnosterna minor* Linell, Proc. U. S. Nat. Mus. XVIII, p. 728.
 1916. *Phyllophaga implicita* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.
 1916. *Phyllophaga minor* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

Implicita ranks sixth in importance in this locality and comprises about 2 per cent of the total collections. This species is comparatively rare at lights, and during 1917 and 1918 about 87 per cent of the 344 beetles taken were found on trees. The collections show that the females greatly predominate, 95 per cent of the total collection being of this sex.

Collections: At lights, 240; on food plants, 489; in soil, 11; total, 740.

Period of flight: May 6 to July 21.

Principal food plants: Willow.

Incidental food plants: Apple, silver poplar, cottonwood, locust, hackberry, linden, elm, hawthorne, redbud, horse chestnut, cherry, curled dock.

Lachnosterna hirticula Knoch.

1801. *Melolontha hirticula* Knoch, Neue. Beytr. Ins. I, p. 79.
 1817. *Melolontha hirticula* Schonherr, Syn. Ins. I, 3, p. 173.
 1842. *Phyllophaga hirticula* Harris, Rept. Ins. of Mass., 2 Ed., p. 28.
 1855. *Ancylonycha hirticula* Burmeister, Handb. Ent. IV, 2, p. 327.
 1856. *Lachnosterna hirticula* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 254.
 1887. *Lachnosterna hirticula* Horn, Trans. Amer. Ent. Soc. XIV, p. 266.
 1889. *Lachnosterna hirticula* Smith, Proc. U. S. Nat. Mus. XI, p. 516.
 1916. *Phyllophaga hirticula* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

Hirticula ranks eighth in importance in this locality. The specimens from this locality have fewer hairs than those collected further east, and Mr. J. J. Davis, in correspondence, suggests that the form found in Kansas may be a variety.

Collections: At lights, 524; on food plants, 50; total, 574.

Period of flight: May 17 to August 7.

Principal food plants: Hawthorne, birch and oak.

Incidental food plants: Persimmon, coffee tree, elm, plum and horse chestnut.

Additional notes: The Agricultural College collection contains ten specimens found feeding on *Ceanothus ovatus*, dogwood and shoestring plant in May, 1889. There are also four specimens taken on willow at the same time.

Lachnosterna ilicis Knoch.

- 1801. *Melolontha ilicis* Knoch, Neue. Beytr. Ins. I, p. 75.
- 1830. *Melolontha porcina* Hentz, Trans. Amer. Phil. Soc. (2) III, p. 256.
- 1850. *Ancylonycha ilicis* Blanchard, Cat. Coll. Ent. Mus. Nat. Hist. de Paris I, p. 133.
- 1855. *Ancylonycha fimbriata* Burmeister, Handb. Ent. IV, 2, p. 326.
- 1856. *Lachnosterna ciliata* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 253.
- 1856. *Lachnosterna ilicis* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 253.
- 1887. *Lachnosterna ilicis* Horn, Trans. Amer. Ent. Soc. XIV, p. 268.
- 1887. *Lachnosterna ciliata* Horn, Trans. Amer. Ent. Soc. XIV, p. 269.
- 1889. *Lachnosterna ilicis* Smith, Proc. U. S. Nat. Mus. XI, p. 517.
- 1889. *Lachnosterna ciliata* Smith, Proc. U. S. Nat. Mus. XI, p. 517.
- 1916. *Phyllophaga ilicis* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
- 1916. *Phyllophaga porcina* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
- 1916. *Phyllophaga fimbriata* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
- 1916. *Phyllophaga ciliata* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

One male of this species was taken under an electric light June 23, 1917.

Lachnosterna crenulata Froelich.

- 1792. *Melolontha crenulata* Froelich, Der Naturforscher, Stueck 26, p. 94.
- 1801. *Melolontha crenulata* Froelich, Der Naturforscher, Stueck 29, p. 111.
- 1817. *Melolontha georgicana* Gyllenhal, Schon. Syn. Ins., Band I, Teile 3, p. 171; appendix, p. 77.
- 1855. *Ancylonycha crenulata* Burmeister, Handb. Ent. IV, 2, p. 327.
- 1856. *Lachnosterna crenulata* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 258.
- 1887. *Lachnosterna crenulata* Horn, Trans. Amer. Ent. Soc. XIV, p. 272.
- 1889. *Lachnosterna crenulata* Smith, Proc. U. S. Nat. Mus. XI, p. 518.
- 1916. *Phyllophaga crenulata* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 370.
- 1916. *Phyllophaga georgicana* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 370.

Crenulata is not common to this area. It appears late in the season, and apparently is not strongly attracted to lights.

Collections: At lights, 32; on food plants, 43; total, 75.

Period of flight: June 2 to September 3.

Principal food plants: Linden.

Incidental food plants: Birch, horse chestnut, strawberry, locust, cherry, hawthorne, plum, Virginia creeper, elm, box elder, willow.

Lachnosterna rubiginosa LeConte.

- 1856. *Lachnosterna rubiginosa* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 259.
- 1887. *Lachnosterna rubiginosa* Horn, Trans. Amer. Ent. Soc. XIV, p. 275.
- 1889. *Lachnosterna rubiginosa* Smith, Proc. U. S. Nat. Mus. XI, p. 519.
- 1916. *Phyllophaga rubiginosa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

Rubiginosa ranks second among the night-flying *Lachnosterna* of Riley county, comprising 15 per cent of the total collections. Knaus (1897), in reporting this species from Douglas county and Manhattan, speaks of it as being rare. The collections show that *rubiginosa* is more abundant on food plants than at lights. The males greatly predominate in the collections made at lights, while there is a slight preponderance of females in those from trees.

Collections: At lights, 1,798; on food plants, 4,236; in soil, 47; total, 6,081.

Period of flight: April 18 to August 8.

Principal food plants: Hawthorne, horse chestnut, locust, hackberry, oak, elm, coffee tree.

Incidental food plants: Linden, birch, Norway maple, redbud, tulip, box elder, ash, apricot, cherry, peach, persimmon, strawberry, silver poplar, larch.

Additional notes: The Agricultural College collection contains 149 specimens found feeding on *Ceanothus ovatus*, dogwood, and shoestring plant dur-

ing May, 1889. Most of these were on the former. There is also one specimen which was shaken from a maple tree at 1 p. m. June 7, 1889, and one beetle that was taken on plum, May 9, 1892.

Lachnosterna submucida LeConte.

- 1856. *Lachnosterna submucida* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 260.
- 1887. *Lachnosterna submucida* Horn, Trans. Amer. Ent. Soc. XIV, p. 277.
- 1889. *Lachnosterna submucida* Smith, Proc. U. S. Nat. Mus. XI, p. 519.
- 1916. *Phyllophaga submucida* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

A rare species in this locality, appearing late in the season. While it is apparently a night flier, two specimens were collected while feeding during the day. In a series of *Lachnosterna* collected at Junction City in June and July, 1916, this species comprised 40 per cent of the total number taken.

Collections: At lights, 13; on food plants, 2; in soil, 2; total, 17.

Period of flight: July 7 to August 17.

Food plants: Big bluestem.

Lachnosterna glabricula LeConte.

- 1856. *Lachnosterna glabricula* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 260.
- 1887. *Lachnosterna glabricula* Horn, Trans. Amer. Ent. Soc. XIV, p. 277.
- 1888. *Lachnosterna glabricula* Bates, Biol. Centr. Amer. Col. II, 2, p. 210.
- 1889. *Lachnosterna glabricula* Smith, Proc. U. S. Nat. Mus. XI, p. 520.
- 1916. *Phyllophaga glabricula* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

Glabricula is rather common during July and August. With the exception of three females taken in the soil around the roots of sumac, the collections have consisted of males. The female of this species has not been described and it is only recently that it has been recognized.

Collections: At lights, 252; on food plants, 1; in soil, 4; total, 257.

Period of flight: June 28 to September 6.

Food plants: Horseweed.

Lachnosterna inepta Horn.

- 1887. *Lachnosterna inepta* Horn, Trans. Amer. Ent. Soc. XIV, p. 282.
- 1889. *Lachnosterna inepta* Smith, Proc. U. S. Nat. Mus. XI, p. 520.
- 1916. *Phyllophaga inepta* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

One male was taken under an electric light September 5, 1917. This is the first record of this species occurring in this state.

Lachnosterna affabilis Horn.

- 1887. *Lachnosterna affabilis* Horn, Trans. Amer. Ent. Soc. XIV, p. 283.
- 1889. *Lachnosterna affabilis* Smith, Proc. U. S. Nat. Mus. XI, p. 521.
- 1916. *Phyllophaga affabilis* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

One male of this species was taken under an electric light August 13, 1917. *Affabilis* was described by Horn from specimens obtained in Kansas, and in so far as the writers have been able to determine, it has not been recorded elsewhere. In addition, the Agricultural College collection contains one specimen collected at lights July 27, 1889, and one specimen caught in a trap in an orchard July 29, 1889.

Lachnosterna tristis Fabricius.

- 1781. *Melolontha tristis* Fabricius, Species Insectorum, I, p. 39.
- 1801. *Melolontha pilosicollis* Knoch, Neue. Beytr. Ins. I, p. 85.
- 1817. *Melolontha pilosicollis* Schoenherr, Sys. Ins. I, 3, p. 177.
- 1817. *Melolontha tristis* Schoenherr, Sys. Ins. I, 3, p. 195.
- 1823. *Melolontha pilosicollis* Say, Journ. Acad. Nat. Sci. Phila. III, p. 243; Ed. Le Conte (1869), p. 143.
- 1842. *Melolontha pilosicollis* Harris, Rept. Ins. of Mass. Inj. Veg. Ed. 2, p. 28.
- 1847. *Trichesthes pilosicollis* Erichson, Naturges. der Ins. Deutschlands III, p. 668.
- 1850. *Trichesthes pilosicollis* Blanchard, Cat. of Coll. Ent. Mus. Nat. Hist. de Paris I, p. 141.
- 1855. *Ancylonycha tristis* Burmeister, Handb. Ent. IV, 2, p. 358.
- 1856. *Lachnosterna tristis* Le Conte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 261.
- 1873. *Lachnosterna pilosicollis* Le Conte, Proc. Acad. Nat. Sci. Phila. XXV, p. 330.
- 1887. *Lachnosterna tristis* Horn, Trans. Amer. Ent. Soc. XIV, p. 286.
- 1889. *Lachnosterna tristis* Smith, Proc. U. S. Nat. Mus. XI, p. 522.
- 1916. *Phyllophaga tristis* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 370.
- 1916. *Phyllophaga pilosicollis* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 370.

A rare species in this locality, six specimens having been taken in the three years collecting.

Collections: At lights, 1; on food plants, 1; in soil, 4; total, 6.

Period of flight: May 23 to June 5.

Food plants: Willow.

Additional notes: The Agricultural College collection contains one specimen taken on willow, May 22, 1889, and one specimen from *Ceanothus ovatus*, May 23, 1889.

ADDITIONAL SPECIES.

Lachnosterna ephelida Say.

1825. *Melolontha ephelida* Say, Journ. Acad. Nat. Sci. Phila. V, I, p. 196; Le Conte, Ed. II (1869), p. 298.
1855. *Trichestes ephelida* Burmeister, Handb. Ent. IV, 2, p. 359.
1856. *Lachnosterna ephelida* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 241.
1856. *Lachnosterna burmeisteri* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 242.
1887. *Lachnosterna ephelida* Horn, Trans. Amer. Ent. Soc. XIV, p. 225.
1889. *Lachnosterna ephelida* Smith, Proc. U. S. Nat. Mus. XI, p. 496.
1916. *Phyllophaga ephelida* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
1916. *Phyllophaga burmeisteri* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

The collection of the department of entomology contains one male collected at lights, July 21, 1903, by N. L. Towne.

Lachnosterna balia Say.

1825. *Melolontha balia* Say, Journ. Acad. Nat. Sci. Phila. V, p. 191; Ed. LeConte (1869), p. 297.
1855. *Ancylonycha comata* Burmeister, Handb. Ent. IV, 2, p. 337.
1856. *Lachnosterna balia* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 255.
1887. *Lachnosterna balia* Horn, Trans. Amer. Ent. Soc. XIV, p. 262.
1889. *Lachnosterna balia* Smith, Proc. U. S. Nat. Mus. XI, p. 516.
1916. *Phyllophaga balia* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
1916. *Phyllophaga comata* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

Knaus (1897) reports this species as occurring in the collection of the Agricultural College from Manhattan. Thus far the writers have been unable to locate the specimens. Knaus says *balia* is rare.

Lachnosterna parvidens Le Conte.

1856. *Lachnosterna parvidens* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 259.
1887. *Lachnosterna parvidens* Horn, Trans. Amer. Ent. Soc. XIV, p. 275.
1889. *Lachnosterna parvidens* Smith, Proc. U. S. Nat. Mus. XI, p. 519.
1916. *Phyllophaga parvidens* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 373.

Reported by Knaus (1897) as occurring in the collection of the Agricultural College from Manhattan. According to Knaus, it is rare in this state.

Lachnosterna forsteri Burmeister.

1855. *Ancylonycha forsteri* Burmeister, Handb. Ent. IV, 2, p. 325.
1856. *Lachnosterna semicibrata* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 247.
1856. *Lachnosterna lugubris* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 248.
1856. *Lachnosterna lutescens* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 249.
1887. *Lachnosterna politula* Horn, Trans. Amer. Ent. Soc. XIV, p. 248.
1887. *Lachnosterna lutescens* Horn, Trans. Amer. Ent. Soc. XIV, p. 248.
1887. *Lachnosterna forsteri* Horn, Trans. Amer. Ent. Soc. XIV, p. 248.
1887. *Lachnosterna lugubris* Horn, Trans. Amer. Ent. Soc. XIV, p. 248.
1887. *Lachnosterna semicibrata* Horn, Trans. Amer. Ent. Soc. XIV, p. 248.
1889. *Lachnosterna nova* Smith, Ent. Amer. V, p. 95.
1889. *Lachnosterna politula* Smith, Proc. U. S. Nat. Mus. XI, p. 507.
1889. *Lachnosterna forsteri* Smith, Proc. U. S. Nat. Mus. XI, p. 508.
1889. *Lachnosterna semicibrata* Smith, Proc. U. S. Nat. Mus. XI, p. 508.
1889. *Lachnosterna nova* Smith, Proc. U. S. Nat. Mus. XI, p. 509.
1916. *Phyllophaga forsteri* Glasgow, Bull. Ill. State Lab. Nat. Hist., XI, p. 372.
1916. *Phyllophaga semicibrata* Glasgow, Bull. Ill. State Lab. Nat. Hist., XI, p. 372.
1916. *Phyllophaga lugubris* Glasgow, Bull. Ill. State Lab. Nat. Hist., XI, p. 372.
1916. *Phyllophaga lutescens* Glasgow, Bull. Ill. State Lab. Nat. Hist., XI, p. 372.
1916. *Phyllophaga politula* Glasgow, Bull. Ill. State Lab. Nat. Hist., XI, p. 372.
1916. *Phyllophaga nova* Glasgow, Bull. Ill. State Lab. Nat. Hist., XI, p. 372.

This species is reported by Knaus (1897) from Manhattan and Topeka under the name *Lachnosterna fraterna* variety *lugubris* LeConte.

Lachnosterna fraterna Harris.

1842. *Phyllophaga fraterna* Harris, Rept. Ins. Inj. Veg. Mass., p. 29; Ed., 2, p. 28.
1850. *Ancylonycha fraterna* Blanchard, Cat. Coll. Ent. Mus. Nat. Hist. de Paris, p. 133.
1855. *Ancylonycha cognata* Burmeister, Handb. Ent. IV, 2, p. 323.

1856. *Lachnosterna cognata* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 248.
 1856. *Lachnosterna fraterna* LeConte, Journ. Acad. Nat. Sci. Phila. (2) III, p. 249.
 1887. *Lachnosterna fraterna* Horn, Trans. Amer. Ent. Soc. XIV, p. 251.
 1887. *Lachnosterna cognata* Horn, Trans. Amer. Ent. Soc. XIV, p. 252.
 1889. *Lachnosterna fraterna* Smith, Proc. U. S. Nat. Mus. XI, p. 508.
 1889. *Lachnosterna cognata* Smith, Proc. U. S. Nat. Mus. XI, p. 508.
 1891. *Lachnosterna fraterna* Hamilton, Ent. News, II, p. 136.
 1916. *Phyllophaga fraterna* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
 1916. *Phyllophaga cognata* Glasgow, Bull. Ill. State Lab. Nat. Hist., p. 371.

Fraterna is reported by Knaus (1897) as occurring in the Agricultural College collection from Riley county. He says that it is present during July and is a rare species.

Lachnosterna profunda Blanchard.

1850. *Ancylonycha profunda* Blanchard, Cat. Coll. Ent. Mus. Nat. Hist. de Paris, I, p. 132.
 1855. *Ancylonycha profunda* Burmeister, Handb. Ent. IV, 2, p. 321.
 1873. *Lachnosterna profunda* LeConte, Proc. Acad. Nat. Sci. Phila. XXV, p. 330.
 1887. *Lachnosterna profunda* Horn, Trans. Amer. Ent. Soc. XIV, p. 257.
 1889. *Lachnosterna profunda* Smith, Proc. U. S. Nat. Mus. XI, p. 513.
 1889. *Lachnosterna biimpressa* Smith, Ent. Amer. V, p. 97.
 1889. *Lachnosterna biimpressa* Smith, Proc. U. S. Nat. Mus. XI, p. 511.
 1897. *Lachnosterna grandior* Linell, Proc. U. S. Nat. Mus. XVIII, p. 727.
 1916. *Phyllophaga profunda* Glasgow, Bull. Ill. State Lab. Nat. Hist., XI, p. 371.
 1916. *Phyllophaga biimpressa* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.
 1916. *Phyllophaga grandior* Glasgow, Bull. Ill. State Lab. Nat. Hist. XI, p. 371.

Smith (1889) described *Lachnosterna biimpressa* from a single male from Manhattan, 1876. According to Glasgow (1916), *biimpressa* is a synonym of *profunda*.

In addition to the species listed above, Knaus (1897) reports *Lachnosterna albina* Burm., *L. subpruinosa* Casey, and *L. marginalis* Lec. as occurring in the collection of the Agricultural College from Riley county. In going over this collection the writers found five specimens labeled *albina*. These were submitted to Mr. J. J. Davis, who pronounced them *rubiginosa*. The specimens of *subpruinosa* have not been found, but in conversation with Dr. R. D. Glasgow he stated that this species is strictly an eastern form. A large number of specimens labeled *marginalis* in the College collection proved to be *rugosa*.

SUMMARY.

The genus *Lachnosterna* offers an excellent field for the study of many phases of insect bionomics, and especially some of the problems concerned in animal distribution. It is necessary, however, that extensive collections of beetles be made from many localities in each state before the definite distribution can be worked out.

The members of this genus include some of the most injurious insects occurring in the United States. They attack crops of all kinds, causing a loss of many millions of dollars annually.

Distribution is influenced by a number of factors, chief of which are latitude, altitude, temperature, moisture, food and soil.

Dispersal occurs principally in the adult stage, and may be by flight, winds, storms, floods or running water.

The genus *Lachnosterna*, composed of approximately 232 species, is confined almost entirely to the Western Hemisphere. Ninety-seven species have been recorded from the United States, and about fifty of these occur in Kansas.

During the past three years the writers have collected 41,633 beetles, representing 23 species, in the vicinity of Manhattan. Six additional species have been reported from this locality and are added to the list.

An annotated list of the 29 species is presented, with notes on relative abundance, period of flight, and food.

Five species, *crassissima*, *lanceolata*, *rubiginosa*, *futilis* and *rugosa*, occur in sufficient numbers to be a serious menace to crops. Five other species occurred in moderate numbers, indicating that they may at times become injurious. These are *implicata*, *bipartita*, *hirticula*, *vehemens*, and *glabricula*.

Four species, *longitarsa*, *crenulata*, *fusca* and *congrua*, are not common to this locality; and nine species, *prætermisssa*, *inversa*, *fervida*, *corrosa*, *ilicis*, *submucida*, *inepta*, *affabilis* and *tristis*, are rare.

Six additional species are represented in the collection of the Agricultural College, or reported in literature from this locality. These are *ephilida*, *balia*, *parvidens*, *forsteri*, *fraterna* and *profunda*.

Two of the species represented in the writers' collection, namely, *prætermisssa* and *inepta*, have not been previously reported from Kansas.

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Notes on Larval Trematodes from the Laramie Plains.

EARL C. O'ROKE.

During the past two summers the writer has been studying the fauna of the Laramie plains in southern Wyoming, in the hope that data might be obtained that would be of use in solving the problems involved in the life histories of some of the trematode worms.

The Laramie plains are peculiarly situated geographically, in that there are mountain barriers to the east, south and west. The only stream that drains the region is the Laramie river, which flows in a northeasterly direction and joins the Platte. Rapids in this stream where it goes through the mountains constitute an effective barrier to many forms of aquatic life. Ponds are numerous in the vicinity of Laramie, almost all of them being alkaline and having their source of water supply in seepage from irrigation ditches. These ponds have an abundant growth of algæ and other forms of plant life and harbor myriads of small crustaceans belonging to the Entomostraca, as well as numer-